

# **Introduction to Biology**

## **Science:**

Our universe operates under certain principles. For understanding of these principles, the experiments are done and observations are made; on the basis of which logical conclusions are drawn. Such a study is called "Science". In brief science is the knowledge based on experiments and observations.

## **Biology:**

The Scientific study of living organisms is called Biology. The word biology is derived from two Greek words "bios" meaning life and "logos" meaning thought, discourse, reasoning or study. It means that all aspects of life and every type of living organism are discussed in biology.

## **Branches of Biology:**

Biology is divided into following branches:

### **Morphology**

The study of form and structure of living organisms is called morphology. It can be further divided into following two parts:

1. The study of external parts of living organism is called external morphology.
2. The study of internal parts of living organism is called internal morphology or anatomy.

### **Histology**

the study of cells and tissues with the aid of the microscope is called Histology.

### **Cell Biology**

The study of structure and functions of cells and their organelles is called Cell Biology.

### **Physiology**

the study of different functions performed by different parts of living organism is called Physiology.

## **Ecology**

The study of organisms in relation to each other and their environment is called Ecology or Environmental Biology.

## **Taxonomy**

Living organisms are classified into groups and subgroups on the basis of similarities and differences. This is called classification. Taxonomy is that branch of biology in which organisms are classified and given scientific names.

## **Embryology**

The study of development of an organism from fertilized egg (zygote) is called embryology. The stage between zygote and newly hatched or born baby is called embryo.

## **Genetics**

The study of methods and principles of biological inheritance of characters from parents to their offspring is called genetics.

## **Paleontology**

The body parts of ancient organisms or their impressions preserved in rocks are called fossils. The study of fossils is called paleontology. It also includes the study of origin and evolution of organisms.

It can be divided into two parts:

1. The study of fossils of plants is called Palaeobotany.
2. The study of fossils of animals is called Palaeozoology.

## **Biochemistry**

The study of metabolic reactions taking place in living organisms is called biochemistry. These reactions may be constructive or destructive. The assimilation of food is a constructive process and respiration is a destructive process.

## **Biotechnology**

It is the branch of biology which deals with the practical application of organisms and their components for the welfare of human beings e.g. disinfections and preservations of food, preservations of insulin and biogas from bacteria etc.

## **Relationship of Biology with other Sciences:**

In ancient times, there was no distinction of biology and other sciences. Different fields of sciences like biology, chemistry, physics and mathematics are met together in the writings of ancient scientists. In ancient times, these subjects were studied under one head "science", but with the passage of time, the science developed very much and the huge scientific knowledge was then divided into different branches.

However even today the interrelationship of these branches cannot be denied.

### **Biophysics**

The study of various biological phenomena according to principles of physics is called biophysics. For example, movement of muscles and bones based on principles of physics.

### **Biochemistry**

The study of different biochemical like carbohydrates, proteins and nucleic acids etc found in cells of living organisms and hundreds of the underlying chemical reactions in cells of organisms is called biochemistry.

### **Biometry**

The data obtained from observations and experiments on living organism is analyzed by various statistical methods. This is called Biometry.

### **Biogeography**

The study of plants and animals and the basis of geographical distribution is called Biogeography.

### **Bio-Economics**

The study of living organisms from economic point of view is called Bio-Economics. It includes the study of cost effectiveness and viability of biological projects from commercial point of view.

# Biological Method of Study or Method Used to Solve the Problem of Malaria:

## Observation

Most of the biological investigations start with an observation. After selecting, specific biological problem, observations are made to collect relevant information. For example; take the case of Malaria. Malaria is the greatest killer disease of man for centuries. Malaria was one among many other diseases for which a cure was needed.

In 1878, A French physician, Laveran, studied the blood sample of Malaria patient under microscope and observed tiny creatures in it. These creatures were later called Plasmodium.

## Hypothesis

To solve a scientific problem, one or more possible propositions are made on the basis of the observations. Such a proposition is called a Hypothesis. The hypothesis is tested by scientific method.

## Merits

A good hypothesis has the following merits:

1. It is close to the observed fact.
2. One or more deductions can be made from this.
3. These deductions should be confirmed doing experiments.
4. Results whether positive or negative should be reproducible.

To know the cause of malaria, following hypothesis was made:

***Plasmodium is the cause of Malaria."***

Note: One or more than one possible deductions can be made from the hypothesis.

## Deduction

the logical conclusion drawn from a hypothesis is called deduction. Testing one deduction and finding it correct does not necessarily mean the hypothesis is correct and scientific problem is solved. Actually, if more deductions are found to be correct; the hypothesis will be close to solution of the problem.

## **Experiments**

Following groups are designed to perform experiments:

### **Experimental Group**

It is the group of those people who are affected in some way and we do not know the real cause e.g. a group of malarial patients.

### **Control Group**

It is the group of unaffected people e.g. persons group of healthy persons.

By keeping both of these groups under similar conditions, the difference between them is determined. To know the real cause of malaria, the experts examined the blood of about 100 malarial patients (experimental group). On the other hand, the experts examined the blood of about 100 healthy persons (control group).

## **Results**

During the experiments mentioned above; the plasmodium was found in blood of most of malarial patients. The plasmodium was absent in the blood of healthy persons. These results verified the deductions and thus the hypothesis i.e. the plasmodium is the cause of Malaria, was proved to a considerable extent.

## **Theory**

If hypothesis is proved to be correct from repeated experiments and uniform results, then this hypothesis becomes a theory.

## **Scientific Principle**

When a theory is again and again proved to be correct, then it is called a scientific principle.

## **Contributions of Muslims Scientists in the Field of Biology:**

Many Muslim scientists contributed a lot in the field of biology but the following names are more respectable:

### **Jabar-Bin-Hayan**

Period: 722-817 A.D

Books: Alnabatat and Alhaywan

Contribution: He studied the life of plants and animals and wrote many books about them.

## **Abdul-Malik-Asmal**

Period:741 A.D

Books: Al-Kheil, Al-Ibil, As-Sha, Al-Wahoosh, Khalaqul Insan.

Contributions: He described the body structure and functions of horses, camels, sheep, wild animals and human beings in detail.

## **Abu-Usman-Umer Al-Jahiz**

Books: Al-Haywan

Contribution: He explained the characteristics of about 350 species of animals. He wrote on the life of aunts especially.

## **Al-Farabi and Abu-ul-Qusim Al-Zahravi**

Period: 870-950 A.D

Books: Al-Nabatat, Al-Haywanat

Contribution: The above mentioned books were written by Al-Farabi. On the other hand, Al-Zahravi was famous for removal of stone from urinary bladder.

## **Ibn-ul-Haitham**

Period: 965-1039 A.D

Books: Al-Manazir, Mizan-ul-Hikma

Contributions: Both of these books were famous and well known at that time. These books were translated into Latin, Hebrew, Greek and other western languages. He explained the structure and functions of eyes and suggested the cornea as a site of vision.

## **Bu-Ali Sina**

Period: 980 A.D

Book: Al-Qanoon Fil Tib Al-Shifa

Contribution: He wrote about plants, animals and non-living things in one book. He was expert in mathematics, astronomy, physics and paleontology.

## **Ibn-ul-Nafees**

Contribution: he described the blood circulation in the human body.

## **Ali Ibne Isa**

Contribution: He worked on structure, functions of eye and about 130 diseases of eyes and their treatment.

## **Non-Muslim Scientists:**

There is long list of non-Muslim scientists who contributed a lot in the field of biology. But, the following scientists are very well known.

### **Aristotle**

Period: 382-322 A.D

Book: Historia Animalia

Contribution: He classified the animals and called as founder of biological classifications. He classified animals into two units, genus and species which was called Oedos.

### **Theophrastus**

Contribution: He accepted sex in plants and described about 500 plants. He is known as father of botany.

### **Visalius**

Period: 1514-1564 A.D

Contribution: He wrote a book on human body structure in which he described bones, muscles and organs in detail.

### **William Harvey**

Period: 1578-1657 A.D

Contribution: He described the blood circulation in human body.

## **Carolous Linnaeus**

Period: 1507-1778 A.D

Contribution: He described the blood circulation in human body.

## **Carolous Linnaeus**

Period: 1578-1657 A.D.

Contribution: He gave a system of binomial nomenclature. He is known as father of taxonomy.

## **Schleiden and Schwann**

Contribution: Schleiden (1838) studied the cells of plants and Schwann (1839) studied the cells of animals. They proposed the cell theory.

## **Louis Pasteur**

Period: 1822-1895 A.D

Contribution: He proved that microbes are found in the air which spoils the food items.

## **Edward Jenner**

Period: 1796 A.D

Contribution: He invented method of vaccination against Small Pox.

## **Robert Koch**

Period: 1845-1910 A.D.

Contribution: He discovered bacteria as causes of main diseases like Tuberculosis.

## **Joseph Lister**

Period: 1860 A.D

Contribution: He made antiseptic medicines like Iodine and Carbolic acid.

## **Charles Darwin**

Period: 1859 A.D

Book: Origin of Species by Natural Selection

Contribution: He explained concept of evolution in his book.

## **Gregor Mendel**

Period: 1822-1884 A.D

Contribution: He conducted experiments on Pea plants. He formulated the laws of inheritance. He is known as father of modern genetics.

## **William Lawrence and William Henry**

Period: 1882 A.D

Contribution: They discovered X-ray crystallography to understand the structure of deoxyribonucleic acid (DN). They were father and son.

## **Francis Crick and James Watson**

Period: 1953 A.D

Contribution: He discovered the double helix model of DNA and proved that DNA is found in cells of all living organisms.

## **Significance of Biology or Impact of Biological Study on Human Life:**

the present high level achievements of man are largely due to the advanced biological research. The study of biology is very important in routine matters of our life as described below.

### **Food Production**

Food has basic importance in our life. Due to researches in biology, there are great achievements in agriculture. For the production of cereal crops; the best varieties of seeds were selected. The yield of wheat corn, rice, sugarcane and cotton has been enormously increased bringing healthy effect and prosperity. Today, the man has overcome the problems of balanced diet, food storage and famine.

## **Control on Diseases**

Health is basic necessity of life. Due to researches in biology, the discovery of new antibiotics for many infectious diseases like plague, cholera, pneumonia, tuberculosis and typhoid has made the life easy. The infant mortality has reduced due to discovery of vaccines for fatal diseases like small pox, polio, tetanus and diphtheria. Today AIDS is problem for world. The germs of this disease destroy the natural resistance and immunities against diseases.

A medicine called AZT has been found effective for AIDS. Similarly many drugs have been discovered for treatment of cancer. Many organisms are used to produce drugs e.g. bacteria and fungi. We have controlled many infectious diseases by using drugs like penicillin and streptomycin. We have eliminated many harmful pests like locusts, flour beetle, termites, fungi, shipworm etc by using pesticides.

## **Genetic Engineering**

Genetic engineering is a technology in which useful genes are inserted into the bacteria etc, to get required beneficial results. Using this technique, manipulation of heredity material is done and new species are produced e.g. Doli sheep. Today human insulin gene is inserted into DNA of bacteria to synthesize insulin on commercial bases. This insulin is found to be very useful in treatment of diabetic patients.

## **Pollution Control**

Due to increasing urbanization, industrialization and automobiles, the man and other organisms have to face a great danger, "the environmental pollution". due to pollution of air, land and water there is danger to humans and wild life. Many plants and animals have been maintaining the balance in our environment for millions of years and now at the verge of extinction due to pollution. By biological research, scientists are busy to find out causes and ways to control the pollution. The biology thus, has greatly improved the quality of our life.

## **Space Biology**

On Mars, some evidence of life has been found which is still under further investigation. During exploration of space the scientists have been conducted experiments on different plants, animals, fungi and bacteria in space and they have obtained very useful information.

## **Islamic concepts About Origin of Life:**

We have got much information about origin of life by studying the Holy Quran.

## **Ultimate Creator**

The first thing learnt from teachings of Quran is that Allah is the ultimate creator of everything whether plants, animals or non-living things.

***"Allah is the creator of all things and He is Guardian of overall things." - (Surah Zamar-Ayat 62)***

Not only plants, animals and non-living things and human beings but also the heavens and whole universe have been created by Allah.

## **Origin of Life from Water**

The second important fact we get from Quran is that Allah has created all living things from water.

***"We made every thing from water." - (Sura Ambia - Ayat 30)***

Viruses, bacteria, algae, fungi, different plants, all animals and humans are all living things. According to Quranic verses, all diverse living things were created from water.

## **Common Origin**

From above mentioned sayings of God there is an indication for common origin of living things or we can at least say that all living things have come out from water.

## **Creation of Man**

Allah also says in Quran:

***"He created man from clay like the potter's." - (Sura Rehman - Ayat 14)***

It seems that there were following two stages for creation of man:

1. Creation from water.
2. The first created thing, on admixing with clay was transformed into more advanced beings.

The same can also be applied to other animals because there are certain similarities between structure of man and other animals. In vertebrate animals, the structures of digestive system, respiratory system, blood circulatory system, excretory system and reproductive system etc are similar to great extent, although differ in other details. Reproduction in living things.

Once the life had been created, Allah implemented the process of reproduction for the continuity of races of animals and other organisms. The various stages of reproduction have been described in sura in following way:

*"Then fashioned we drop a clot, then fashioned we clot a little lump, then fashioned we the lump bones, then clothed the bones with flesh." - (Sura Almominoon Ayat 14)*

## **Classification and Evolution**

*"Allah has created every animal from water some of them creep up on their bellies, other walk on two legs, and others on four, Allah creates what he pleases. He has power over all things." - (Sura Nur Ayat 45)*

*"Hath there come upon man (every) any period of time in which he was a thing unremembered?" - (Sura Dahar Ayat 1)*

The close study of above sayings of God reveals that all animals had a common origin but they gradually underwent changes after words and became different from each other i.e. some animals became crawler, some bipedal and some other tetrapods. The present animals are advanced forms of the past animals who achieved this form after passing through many changes.

## **Concept of Abiogenesis and Biogenesis for Origin of Life on Planet Earth:**

### **Scientific Views About Origin of Life**

How did life originate on this earth? This may never be known for certain to science because neither it is possible today to make observation of primitive events when the life actually originated nor there is any fossil record of first formed soft bodied organisms. However, in 1950 some scientists created the primitive earth condition (approximately 4 billion years ago) in the laboratory and performed experiments. On the basis of results obtained from these experiments, scientists formulated some ideas. These ideas seem to be close to reality.

### **Abiogenesis and Biogenesis**

In ancient times, there were two views about the origin of life:

1. According to one view, offspring are produced from their parents by process of reproduction, this is called concept of Biogenesis.
2. According to other view, living things are produced spontaneously from non-living things. This is called concept of Abiogenesis.

Because at that time, there was neither so much advancement in science nor scientific tools like microscope and other instruments were invented, which could help in detailed observations about reality. According to some people, insects are produced from dewdrops, rats from debris,

frogs from mud, and maggots from putrefied meat. Some scientists like Copernicus, Bacon, Galileo, Harvey, and Descartes also believed this concept.

From 16th to 18th century many scientists performed experiments to test this concept. They found some animals to be developed from non living matter. Therefore this concept seemed to be correct.

Later on, scientists performed experiments with more care. First of all an Italian scientists, Francesco Redi, (1668) proved that this concept was wrong.

## **Redi's Experiment:**

Redi took four bottles. He put a dead snake in one bottle, a few dead fish in second bottle, dead eel in third bottle and a piece of meat in the fourth bottle. All these bottles were left open. The flies could enter these bottles. Then he took four more such bottles. He put some dead animals in all four bottles but covered the mouth of bottles.

(Figure from book)

After few days, maggots were produced in four open bottles. Maggots were not produced in closed bottles. Moreover, no flies were seen. Therefore, it was proved that maggots were not produced spontaneously but produced due to flies which were visiting the open bottles. The maggots were the larvae produced from the eggs of the visiting flies.

## **Needham's Experiment:**

In 1748, an English scientist Needham boiled the meat in the water and prepared gravy. He poured this gravy into the bottles and closes their mouth with corks. After some days, many microscopic organisms were produced. In this way, the believers of abiogenesis were once again gain courage.

(Figure from book)

## **Experiment of Spallanzani:**

In 1767, an Italian scientists Spallanzani criticized the experiment of Needham. He said that air entered the bottles through the pores of cork and hence living organisms were produced.

(Figure from Book)

Spallanzani put the boiled meat and vegetables in clean bottles and then sealed the mouth of bottles by heat. He placed these sealed bottles in boiled water to kill the possible germs. After some days, he found no organisms. He left the same boiled meat and vegetables in open bottles at the same time. Some living organisms were produced in these bottles. This supported the concept of Biogenesis. But the believers of Abiogenesis said that air removed by Spallanzani was necessary for living things so no organisms were produced in sealed bottles. When oxygen was discovered the supporters of Abiogenesis said that Spallanzani had removed oxygen where by no life could be produced in his experiment.

## **Experiment of Louis Pasteur:**

The argument on Biogenesis and Abiogenesis continued up to the middle of, 19th century. A well-known French scientist, Louis Pasteur proved, after simple but very careful experiments, that abiogenesis could not occur in present environment of earth. He proved that living organisms could only be produced from their parents.

In 1864, Pasteur performed his experiment in front of the commission formed to solve the issue. He took flasks, which had long curved S-shaped necks. He placed fermentable infusion (Yeast + sugar + water) in flasks and left their mouth open.

(Figure from Book)

He boiled the yeast infusion in the flasks. After this, he allowed to cool them and kept them as such. He observed that no life was produced even after the lapse of several days, because microscopic organisms entering along with air got stuck up in on the curved walls of the glass necks. Then he broke up the curved necks, so that air containing microscopic organisms could reach the infusion. Now he noted that microscopic organisms were produced within 48 hours. This proved that if care was taken and no microscopic organisms and reproductive structures (eggs or spores) approach the infusion, no life could be produced because there is no spontaneous generation of life from non life. After Pasteur, no further experiments were performed on origin of life for the next 60 years. In 1920, a Russian biochemist Alexander Oparin and a British biologist J.B.S Haldane suggested that life on earth was originated after a long and gradual molecular evolution and there was no spontaneous and miraculous origin of life on earth.

## **Chemical and Organic Evolution of Life on Earth:**

The modern view of the origin of life stresses on the idea of chemical evolution. According to Oparin and Haldane, the origin of first life had been initiated from the time of the existence of the solar system (the sun with its nine planets). The earth, like the sun was made up of light and heavy elements. Heavy elements like iron, nickel etc were present in the nucleus of the earth, while the light elements and compounds like hydrogen, methane, nitrogen, carbon, ammonia,

nitrogen oxide, etc in the form of vapours existed on the surface of the earth. These light elements and compounds were responsible for the first life on earth.

The earth had high temperature and radiation and had frequent and abundant discharges. In these conditions, the first life originated. Oparin and Haldane suggested that simple inorganic molecules slowly and gradually combined to produce complex organic molecules from which the simplest form of life (bacteria) came into existence. This process took a long time.

Haldane proposed that primitive earth's atmosphere had only carbon dioxide, ammonia and water vapours. If a mixture of these gases is exposed to ultraviolet radiation, it leads to the formation of organic compounds like sugar and amino acids. As free oxygen was not available to check the radiation from reaching the earth so substances like sugar and amino acids went on accumulating under such conditions.

About 15 billion years ago, there was a huge explosion (Big Bang). The universe started expanding and the temperature dropped drastically. In time, about 4.6 billion years ago our earth and other planets appeared as part of the solar system. The primitive atmosphere of the earth was rich in hydrogen.

With the passage of time, the atmospheric temperature gradually dropped. This allowed condensation and heavy rains, which caused formation of oceans. Thunder and lightning sparks together with ultraviolet radiation caused reactions of the atmospheric gases resulting in the formation of simple organic molecules. These molecules came down with the rains and accumulated in the seas, oceans, lakes, rivers and the soil over a very long period of time. These molecules interacted and produced amino acids and proteins which are the body building substances.

The fossil evidence indicates that the earliest forms of organisms lived about 3.8 billion years ago. From this it is speculated that the origin of life started about 4 billion years ago.

The earliest organisms were heterotrophs. The depletion of the pre-existed food from the environment led to the evolution of organisms capable of making their own food. They became autotrophs, and added free oxygen into the atmosphere.

For at least the first 2 billion years of life on earth, all organisms were bacteria. About 1.5 billions years ago, the first eukaryotes appeared.

The idea of organic evolution was supported by scientists like Lamarck and Charles Darwin.

## **Differentiate between Biogenesis and Abiogenesis:**

### **Biogenesis**

- A theory which describes the origin of life on the earth from pre-existing living organisms is called Biogenesis.

- It was based on practical experiments and material evidence.
- It was supported by the experiments performed by Redi and Pasteur.
- It was based on practical basis.
- It describes the process of reproduction as an essential ability of living organisms.

## **Abiogenesis**

- A theory which describes the origin of life on the earth from non living things is called Abiogenesis.
- It was based on observations and national thoughts.
- It was supported by the fungus of bread: and production of frogs in the mud.
- It was based on theoretical basis.
- It gives no scientific reasoning about the production of life.

## **Differentiate between Hypothesis and Theory:**

### **Hypothesis**

- The process of making some possible answers for the related biological problem is called Hypothesis.
- It is the step of biological methods which gives the way to carry on the research.
- Hypothesis is an uncertain intelligent statement.
- Hypothesis is formed from observations and collected facts.

### **Theory**

- The final explanation which is given on the basis of hypothesis and deduction if they are found correct is called theory.
- It is the step of biological method which gives actual reason to biological method.
- Theory is certain intelligent statement.

- Theory is formed by experimentation, physical evidence to explain the laws of nature.

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